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Application of coarse gibbsite agglomerates to formation of 2D and 3D boehmite particles by the dehydration of the hydrothermal treatment and atmospheric pressure

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ABSTRACT

The coarse agglomerates of gibbsite (γ-$Al(OH)_3$) are grateful starting materials for preparation aluminum oxides and hydroxides as boehmite and γ-Al_2O_3, which are extensively used as a catalysts and catalyst support for the petrochemical industry. By preparing the boehmite particles from the gibbsite and product of the heat gibbsite, we demonstrate the influence of different treatments to a morphology and particle size of the formed boehmite (γ-AlOOH). It is been established for the first time that the flaky-shaped 2D γ-AlOOH particles are formed within the coarse agglomerates producing a laminated packaging film lozenge-shaped crystals which results in a 0.1 cm^3/g pore volume and 29 m^2/g specific surface area. The obtained data have a high industrial importance in the area of producing materials based on the coarse boehmite agglomerates with different properties.

1. Introduction

Gibbsite (γ-$Al(OH)_3$) is known to be the cheapest and significant raw materials of alumina–ceramic. γ-$Al(OH)_3$ is a very popular engineering product produced by Bayer method on an industrial scale. Boehmite (γ-AlOOH) can also be synthesized by the direct hydrothermal treatment of gibbsite under the temperature of 120–380 °C at the appropriate saturated vapor pressure of water. In recent years, γ-AlOOH particles with nanoscale dimentions and morphological specificity have attracted enormous interest from both fundamental and practical viewpoints [1–13]. Additionally, γ-AlOOH is one of the most important hydroxides because of their potential for broad applications in petrochemical refining process, advanced catalysis, adsorption, composite materials design and ceramics [1–8]. Boehmite is also used as a flame retardant in plastics and paint materials, as a component of the toothpastes, an enveloping and absorbing material in medicine. Under heat treatment of more than 1000 °C γ-AlOOH turns into corundum which is used in industry as a catalyst support for a partial oxidation in the production of ceramics and constructional materials, abrasives, also in the laser technology and microelectronics. Boehmite is widely used in industry as a precursor of alumina. γ-AlOOH is transformed to γ-Al_2O_3 under heat treatment of 350–750 °C. The alumina is also the most commonly used support material in traditional catalysts designed to remove NO_x from auto exhausts [9]. The alumina is the porous support for the supported ionic liquids phase where ionic liquids is an alternative solvent in a range of catalytic processes as compared to traditional volatile organic solvents for developing greener reactions [10].

Generally, specific properties of the most important aluminum oxides based materials (catalysts, catalyst supports, adsorbents and ceramics) such as a specific surface area, pore volume, shape, size and the granules strength depend largely on the structural characteristics of its precursor (its size, morphology and character packing arrangement of boehmite particles). For example, when γ-AlOOH crystallizes at the deterioration of amorphous aluminum hydroxide at atmospheric pressure or under hydrothermal conditions boehmite particles can be shaped in the form of nanospheres [1], hollow microspheres or microelipsoids [2,3] nanowires [4], the flowers [5], flat sheets [6], nanorods [7] and nanotubes [8] which depend on the synthesis conditions. Mesoporous clusters of spherical boehmite microparticles are obtained by hydrolysis of aluminum metal [11]. To develop a simple synthesis route for the control over the morphology of AlOOH is of great importance for broadening and improving their industrial applications. For example, γ-AlOOH particles in the form of sword [12], in the shape of plates [13] and parallelepipeds [14] were synthesized by the autoclave treatment of γ-$Al(OH)_3$. In the work mentioned above the

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